"GREEN SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF SYNTHESIZED RUTHENIUM NANOPARTICLES USING PLANT EXTRACT".

A
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BY

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Title of the topic	:	"GREEN SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF SYNTHESIZED RUTHENIUM NANOPARTICLES USING PLANT EXTRACT".
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INDEX

Sr. No.	Content	Page Number
1	Title	4
2	Aims of the study	4
3	Objective of the study	4
4	Study Background (Literature Review) and significance of study	5
5	National Status	6
6	International Status	6
7	Study Hypotheses	7
8	Study Rationale	7
9	Research Methodology	7
10	Statistical Plan	8
11	Limitations of the Study	8
12	Expected Outcomes of Study	8
13	Select Bibliography	9

i. Title

"GREEN SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF SYNTHESIZED RUTHENIUM NANOPARTICLES USING PLANT EXTRACT".

ii. Aims of the study

The aim of the study is to green synthesize and characterize ruthenium nanoparticles from plant extract and to study its biological activity. The present work is to develop cost-efficient, environment friendly method for the synthesis of metallic magnetic nanoparticles with improved magnetic properties. They are characterized using various techniques like SEM, TEM etc. In addition to this we are going to check their application in organic synthesis.

iii. Objective of the study

The main objectives of present work are,

- To develop cost-efficient, environment friendly method for the synthesis of metallic magnetic nanoparticles with improved magnetic properties.
- To improve the stability of ruthenium nanoparticles.
- To characterize of synthesized nanoparticles using various techniques like SEM, TEM etc.
- To check their biological activity.
- To investigate of their applicability in organic synthesis.

iv. Study Background (Literature Review) and significance ofstudy

Nowadays, metal nanoparticles (NPs) have received interest in a wide range of research fields because of their fabulous ability as a nanocatalyst having 1 to 100 nm size and gives a good efficiency in the homogeneous and heterogeneous catalysis [1, 2]. The use of MNPs not only offers high catalytic activity and selectivity benefiting from their nanosize, but also fulfills the demands concerning convenient catalyst separation [3]. These features extremely attract the researchers to use NPs as catalyst in various organic reactions. Various methods are used to synthesize metal NPs are biological methods [4, 5] and physicochemical [6]. Therefore, we have planned to develop nontoxic, environment-friendly and simple procedures for the synthesis of ruthenium nanoparticles.

In another aspect, biological techniques have big advantages over physicochemical methods. It involves the use of economically and environment-friendly green chemistry-based approach and used various plant leaves extracts like origanum vulgare[7], salvia hydrangea, Euphorbia thymifolia [8-10] comparison to the rate of reduction of metal ions with plant extract is found to be more effective [11, 12]. However, the use of plant resources for NP synthesis brings up significant drawback, leading to the destruction of ecologically systems like plants and plant parts. The use of various agro wastes for the synthesis of NPs by biological method is an attractive platform in last few decades [13]. Nowadays homogenous catalyst creates a lot of problems some of them are separation from reaction mass also it have less efficiency and may give byproducts. So that homogenous catalyst can be making heterogeneous by using various solid supports [14] it may show good efficiency and easiest separation from reaction mass. Various solid support may be used to synthesize NPs are zeolite, clay and resins as well as biological materials.

Transition metals, on account of their unique bonding properties involved in oxidative and reductive steps, and reaction mechanism, provide newer opportunities for synthetic application as a catalyst [15-16]. Ruthenium complexes are known in a wide range of oxidation states from −2 to +8 and easily accommodate ligands with various coordination geometries, so that they possess unique opportunities as versatile catalysts [17, 18].

In this regard, ruthenium continues to attract gives great interest because of its versatility as a catalyst that mediates various synthetic reactions [19, 20] Among them, Click reaction [20], olefin metathesis [20], oxidation, reduction, cross-coupling reactions and coupling reaction [21], hydrogenation [23] etc are reliable and powerful methods for the synthesis of various product and cyclic derivatives which are part and excellent features in numerous biologically active compounds. Consequently, there is a need to design an eco-friendly, economically, simple step, commercially applicable methods for the synthesis of click reaction product and cyclic derivatives [24].

If plant extract mediated synthesis approach is followed, bioactive compounds of the extract would cap over NPs surface. However, variation of plant species can significantly affect this process, as a particular type of biological activity of a plant is specific to itself and its effectiveness varies from plant to plant. [26]

v. National Status

Gopinath K, Karthika V, Gowri S, studied antibacterial activity of ruthenium nanoparticles using Gloriosa superba L. leaf extract. The present study reports the green synthesis of RuNPs using G. superba leaf extract. The antibacterial activity of RuNPs has significant effects against the gram-positive bacteria compared to gram-negative bacteria. This green synthesis is rapid, facile, convenient, less time consuming and environmentally safe. [5]

Sarwat Iqbal .Catalysis ACS Studied supporting Information Ruthenium nanoparticles supported on carbon - an active catalyst for the hydrogenation of lactic acid to 1,2-propanediol .In the present work studyThe hydrogenation of lactic acid to form 1,2-propanediol has been investigated using Ru nanoparticles supported on carbon as a catalyst. Two series of catalysts which were prepared by wet impregnation and sol-immobilization were investigated. [23]

Pritam Kumar Dikshit, Jatin Kumar reported the green Synthesis of Metallic Nanoparticles: Applications and Limitations. The present review focuses on the green synthesis of metal NPs derived from plants and microorganism and their applications. Green synthesis methods provide a clean, non-toxic, and eco-friendly approach for the synthesis of metal NPs compared to other conventional techniques like physical and chemical methods.[25]

Pranshu K. Gupta, Kalluri V. S. Ranganath, studied green synthesis, characterization and biological activity of synthesized ruthenium nanoparticles using fishtail fern, sago palm, rosy periwinkle and holy basil.In the present study we have synthesized simple cubic Ru NPs (monodispersed) through the green protocolusing plant extracts and utilized plants of medicinal importance in order to establish significant bioactivity.[26]

vi. International Level

Cho JH, Kim BM reported an efficient method for removal of ruthenium byproducts from olefin metathesis reactions.The present review demonstrated a convenient and efficient method for removing ruthenium-containing by product from olefin metathesis reactions by simple aqueous workup. This practical, economical and environmentally friendly method reduced the ruthenium contamination level down to the useful range for biologically active material applications.[19]

Lou BS, Chen SM, Liu S Bin reported Ruthenium nanoparticles decorated curl-like porous carbons for high performance supercapacitors.

Hence, the aim of present work to improve the yield and quality of ruthenium nanoparticles, characterized by various methods and to study their application in organic synthesis.

vii. Study Hypotheses

The methods have been reported to dump toxic chemicals and solvents imposing a hazard to environment and human lives. Hence, development of a new and 'green' protocol for synthesis of NPs is an alternative.

Green synthesis methods provide a clean, non-toxic, and eco-friendly approach for the synthesis of metal NPs compared to other conventional techniques like physical and chemical methods. A wide range of plant materials including leave extract, fruit extract, seed, fruit, bark, etc. and microorganism such as bacteria, fungi, actinomycetes, etc. have shown potential for synthesis of various metal.

Green synthesis of nanoparticles has increased significant importance in recent years as it has several merits such as it is simple, cost-effective, nanoparticles formed have good stability, less time consumption, non-toxic by-products, environment-friendly and can be easily scaled up for large-scale synthesis.

viii. Study Rationale

Green synthesis of ruthenium nanoparticles expects excellent outcome related to develop environment-friendly synthesis, characterization, biological activity and synthetic application.

ix. Research Methodology

➢ Material and Methods

The proposed work is basically divided into three stages.

The first stage of the work involves the microwave and environment-friendly synthesis, of the Ruthenium nanoparticle and their noble metal coated core-shell type analogs. This work will be carried out by using metal salts, eco-friendly solvents and microwave synthesis set up.

In the second stage the synthesized magnetic nanoparticles will be characterized using various characterization techniques.

In the third and last stage of the proposed work the synthesized ruthenium nanoparticles are tested for their applications and biological activity.

1. **UV – Visible spectrophotometer** will be used to monitor the progress of reaction.
2. With the help of **Fourier-transform infrared (FTIR) spectrophotometer** the presence of the functional groups responsible for stabilization of the synthesized nanoparticles will be confirmed.
3. **SAED and X-ray diffraction** technique are usedto identify the phases of synthesized nanoparticles.
4. **Transmission electron microscopic study** will be carried out to determine the size, shape and morphology of synthesized nanoparticles. **Particle size analysis** will be done to understand the particle size distribution.
5. The synthesized magnetic nanoparticles are further investigated for their electrochemical and magnetic properties using **voltammetry and superconducting quantum interference device (SQUID).**
6. The synthesized organic products are characterized by using ^{1}H NMR .

x. Statistical Plan

Months	Plan of Research work
1 to 6	Course work and Literature review
7 to 20	Laboratory work
20 to 27	Result analysis and outcome
27 to 30	Synopsis and thesis writing

xi. Limitations of Study

The particles size of synthesize RuNPs may not be confirmed.

xii. Expected Outcomes of Study

The major outcomes expected from the proposed work are,

1. To develop environment-friendly synthesis of ruthenium nanoparticles.
2. To characterize the synthesized nanoparticles and confirm their sizes.
3. To improve the stability of ruthenium nanoparticles with better catalytic activity.

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